Work Assignment No. 6
MTA Agreement No. 15099-0300

Utica Avenue Transit Improvements Study

Task 2 Deliverable 1: Nostrand Junction

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1 Executive Summary

This report was developed by WSP as part of the Utica Avenue Transit Improvements Study. Nostrand Junction is located where the Nostrand Avenue Line (served by the 2 and 5) diverges from the Eastern Parkway Line (3 and 4). The Eastern Parkway Line consists of four tracks, two local tracks and two express tracks, while the Nostrand Avenue Line is a two-track line. Since its construction, Nostrand Junction has been a bottleneck for the A-Division. Its flat junction configuration requires trains to cross one another at-grade, causing delays that cascade and ripple back through the rest of the A-Division, limiting capacity during peak hours. The issue of how to resolve the bottleneck at Nostrand Junction has been the topic of repeated studies over the past 50 years.

Nostrand Junction is under consideration as one of several stand-alone study locations where operational and capacity improvements could be made to the existing A-Division subway system in Brooklyn, complementary to but independent of any potential transit improvements along the Utica Avenue corridor. This report ascertains whether there are viable methods for resolving the Nostrand Junction bottleneck. This was done by reviewing prior reports as well as analyzing whether there are other additional modifications that could be made to the track layout, infrastructure, or service operations that could increase capacity through this junction that were not proposed in any of the prior reports.

The 1993 New York City Transit (NYCT) document, *A Report on Nostrand Avenue Junction Study: New Lots and Nostrand Avenue Lines,* proposed a wide range of potential solutions. That report considered seven alternatives, which encompassed feasible options to mitigate the Nostrand Junction bottleneck by either introducing grade-separated tracks, additional crossovers, and/or service modifications. Of the seven alternatives studied, two alternatives were selected and recommended for further study, Alternative 4 and 6. Alternative 4 proposed new crossovers to help alleviate the bottleneck, while Alternative 6 proposed fully grade separating Nostrand Junction.

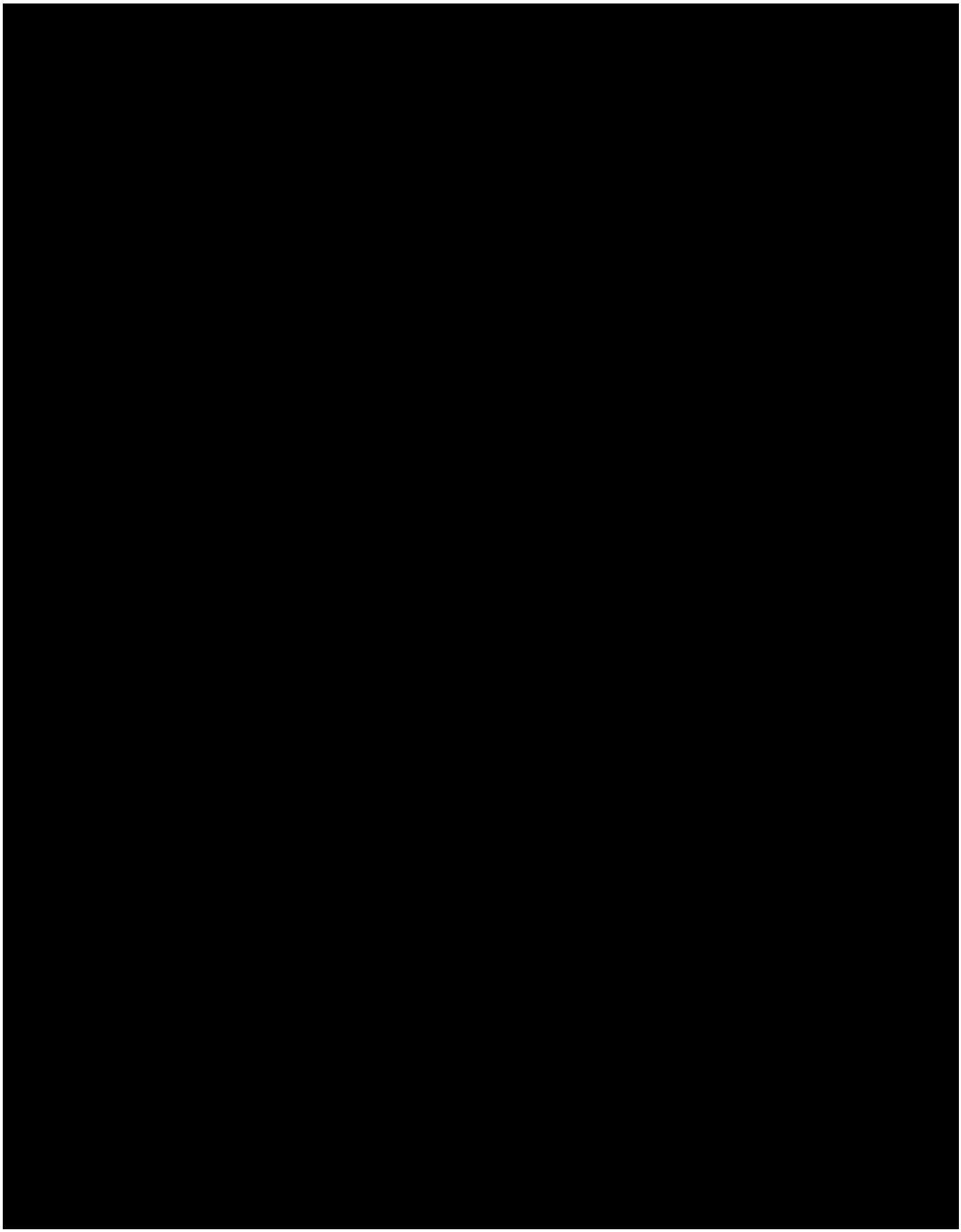
The 2009 NYCT document, *Conceptual Engineering Design Study for Reconfiguration of the Nostrand Junction in Brooklyn,* was a follow-up study to the 1993 report. That study further investigated Alternatives 4 and 6 by developing conceptual designs, construction methods, construction phasing, identifying preliminary community/environmental impacts, and escalating the capital costs.

[redacted]

In addition to the document review, the Utica Avenue Study Team assessed whether there might be other viable options for resolving the Nostrand Junction bottleneck that were not previously considered. No other viable infrastructure improvements at Nostrand Junction were found and the Study Team concurs with the recommendations from the 2009 report that focused on Alternatives 4 and 6.[1]

[redacted]

[1] A separate Task 2 report identifies an opportunity to address the Nostrand Junction bottleneck through an infrastructure improvement at Crown Heights-Utica Av Station.



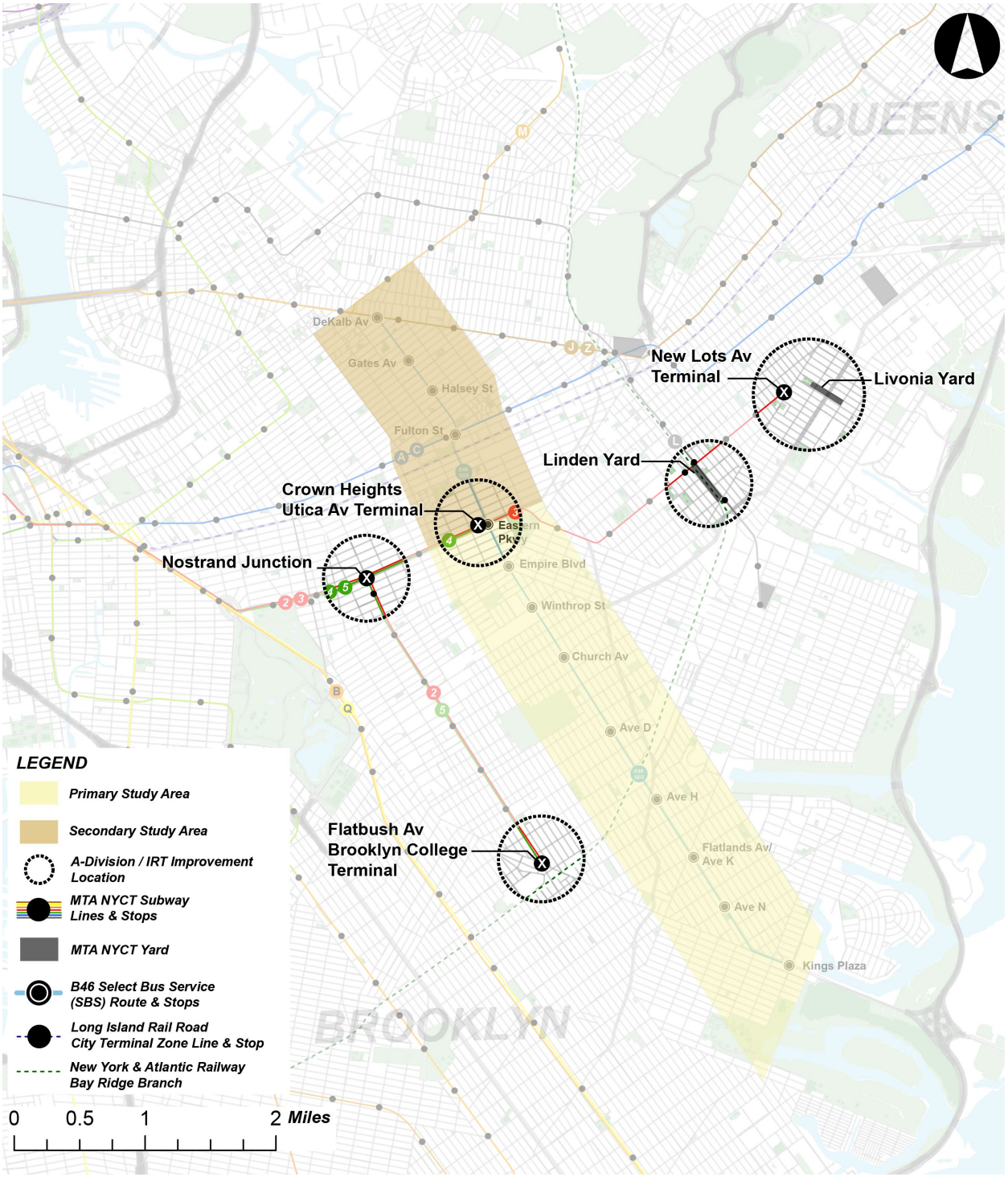
2 Introduction

This report was developed by WSP as part of the Utica Avenue Transit Improvements Study (hereafter, Utica Avenue Study). The report addresses possible infrastructure improvements at Nostrand Junction on the A-Division in Brooklyn and makes a recommendation of an improvement that can be subject to the development of tentative service plans and supporting train operations simulations to verify the accrued benefits. Nostrand Junction has long been recognized as a bottleneck to the A-Division. The flat junction configuration causes train routing conflicts that can create train delays and reduce line capacity. In severe instances, these delays can cascade and ripple back through both the East Side and West Side IRT Lines in Manhattan. These delays prevent the Eastern Parkway, New Lots Av, and Nostrand Av Lines from operating at their maximum capacity during peak hours. The issue of how to resolve the bottleneck at Nostrand Junction has been the topic of repeated studies over the past 50 years and has been the subject of several reports.

Nostrand Junction is one of the five stand-alone study locations where operational and capacity improvements could be made to the existing subway system, complementary to but independent of any potential transit improvements along the Utica Avenue corridor. The intent of the five study locations is to identify methods to increase the existing A-Division and operational flexibility in eastern Brooklyn, and to offer a range of solutions to alleviate existing constrained conditions pertaining to train operation bottlenecks and shortage of train storage or lay-up capability. The other four locations are Flatbush Av Terminal, Crown Heights-Utica Av Terminal, New Lots Av Terminal, and Livonia and Linden Yards (Figure 1). The potential transit service improvements provided at each identified A-Division location would not only contribute to the quality of new or enhanced transit service along the Utica Avenue corridor, but could also offer A-Division service benefits outside the corridor and thus have independent utility.

The purpose of including Nostrand Junction in the Utica Avenue Study was to identify methods for resolving the Nostrand Junction bottleneck. This study began by reviewing the background and prior reports on Nostrand Junction. Thereafter, the Study Team analyzed if there were any additional service design options that could improve reliability of the existing junction function. The review of relevant prior reports informed the evaluation of whether there are any potential track reconfigurations that may simplify interlocking operations through service pattern alterations without the need for a total interlocking redesign. The Study Team found no such interlocking alternatives that had not been previously considered.

Figure 1: Study Area and A-Division Improvement Locations for the Utica Avenue Transit Improvements Study



Source: Utica Avenue Transit Improvements Study

3 Existing Conditions and Constraints

3.1 EXISTING INFRASTRUCTURE AND OPERATIONS

Nostrand Junction, shown in Figure 2, is a key junction where the Nostrand Av Line and Eastern Parkway Line merge and diverge on the A-Division in eastern Brooklyn. Nostrand Junction occupies a line-length of approximately 1,600 feet, located between Franklin Av Station to the NYCT "subway north" and Nostrand Av Station to NYCT "subway south."[4] A glossary that defines these and other subway terminology appears in Appendix A.

Figure 2: Nostrand Junction

Four subway routes operate through Nostrand Junction:

- The 2 (West Side IRT Line) enters Nostrand Junction from the Eastern Parkway Line to access the Nostrand Av Line and serve its southern terminal at Flatbush Av Terminal. The 2 operates at "all times" (24/7) as a local service along the Eastern Parkway and Nostrand Av Lines.
- The 5 (East Side IRT Line) enters Nostrand Junction from the Eastern Parkway Line to access the Nostrand Av Line and serve its southern terminal at Flatbush Av Terminal. During the weekday AM and PM peak periods, the 5 operates as an express service along the Eastern Parkway Line and as a local service along the Nostrand Av Line, where it serves all stations. The 2 and the 5 provide one-seat rides for customers on the Nostrand Av Line to either the East or West Sides of Manhattan.

[4] Per NYCT operations, all trains in the subway system are classified as running either northbound or southbound, even if they are operating on tracks that are actually oriented east-west. Thus, a southbound train along the New Lots Av Line may be heading geographically east but is considered a southbound train. This document uses the term "subway north" and "subway south" to describe train directionality and the relative locations of subway system infrastructure and not geographic directionality.

- The 4 (East Side IRT Line) runs along the full length of the Eastern Parkway Line, passing through Nostrand Junction to terminate at Crown Heights-Utica Av Station, the next and final express station south of Nostrand Junction on this line. The 4 operates as an express service along the Eastern Parkway Line.
- Except for overnight hours, the 3 (West Side IRT Line) runs along the full length of the Eastern Parkway Line, passing through Nostrand Junction to Crown Heights-Utica Av Station.[5] South of Crown Heights-Utica Av Station, the 3 runs along the New Lots Av Line and terminates at New Lots Av Terminal. The 3 operates as a local service along the Eastern Parkway Line and New Lots Av Line. The 3 and the 4 provide one-seat rides for customers boarding at Crown Heights-Utica Av Station (and points north) to either the East or West Sides of Manhattan.

Figure 3 shows the track diagram of the Eastern Parkway Line, which encompasses Nostrand Junction. The segment of the Eastern Parkway Line subway south of Franklin Av Station is located within a bi-level, "stacked" tunnel configuration, with the southbound tracks located on the upper level and the northbound tracks located on the lower level.

This flat junction configuration requires a southbound 5 on the express tracks of the Eastern Parkway Line to cross the junction at-grade via No. 8 turnouts[6], traversing from Track 2 to Track 2A via Track 1. Such a routing takes the 5 service destined to the Nostrand Av Line across the path of the 3 service that operates on the southbound local Eastern Parkway Line tracks. Such moves delay 3 service that proceeds straight ahead on the Eastern Parkway Line.

[5] During overnight hours, the 3 is replaced by the 4.
[6] Turnout is a special track installation used to allow trains to proceed straight ahead or to switch to another track. An explanation of the turnout numbers (i.e. No. 8 turnout) is included in Appendix B.

Similarly, a northbound 5 from the Nostrand Av Line entering the northbound express tracks of the Eastern Parkway Line must cross the junction at-grade via No. 8 turnouts across the path of the northbound local track, going from Track 3A to Track 3 via Track 4. Such crossings by the 5 impede northbound 3 trains along the Eastern Parkway Line.

This track configuration, with the operational bottlenecks that this entails, dates to approximately 1920, the period of the original construction of these two lines.

3.2 EXISTING OPERATIONAL CONSTRAINTS

Since inception, Nostrand Junction has been a bottleneck for the 2, 3, 4, and 5 services. The flat junction requires certain trains to cross other tracks at-grade, constraining line capacity and causing junction-related delays that cascade and ripple back through both the East Side and West Side IRT Lines in Manhattan. These constraints and delays are severe enough that they prevent the New Lots Av and Nostrand Av Lines from operating at their maximum capacity.

In 1993, NYCT issued *A Report on Nostrand Avenue Junction Study: New Lots and Nostrand Avenue Lines* (hereafter, 1993 Nostrand Junction Study). The practical "***capacity***" of Nostrand Junction as shown in the 1993 Nostrand Junction Study is 44 trains per hour (TPH), spread between two northbound tracks and similarly 44 TPH combined for the two southbound tracks. This is divided as follows:

- 2 : 9 TPH (all From Flatbush Av)
- 3 : 9 TPH (all from New Lots Av)
- 4 : 13 TPH (all from Utica Av)
- 5 : 13 TPH (9 from Flatbush Av; 4 from New Lots Av)

This capacity is dependent upon every single train arriving at the junction on its scheduled time with delays of no more than 60 seconds. This causes the signals to space trains out and thus only 38 TPH realistically pass through the junction. This is the "***throughput***." Effectively, six trains (44 – 38) are delayed enough that they do not make it within the 1-hour count.[7]

The 1993 Nostrand Junction Study showed that during the AM peak periods, 41 percent of the Nostrand Av Line services (2 and 5) between President St Station and Franklin Av Station were delayed by an average of 1.65 minutes/train, and that 35 percent of the New Lots Av trains (3, 4 and previously 5) operating between Nostrand Av Station and Franklin Av Station were delayed by an average of 1.1 minutes/train.

Since the 1993 Nostrand Junction Study, there has been a service revision. 5 trains are no longer shown in the public timetables or maps as operating to Crown Heights-Utica Av Station; instead, 5 trains generally operate to Flatbush Av Terminal. In actuality, because of capacity constraints at Nostrand Junction during peak periods, there are "offline" (non-published) 2 and 5 trips along the Eastern Parkway Line and the New Lots Av Line, with trains originating or terminating at New Lots Av Terminal. The appearance of such offline trains can confuse the public.

[7] With respect to customer volume, the difference between the 44 TPH maximum capacity and the 38 TPH throughput translates to a difference of 10,920 passengers. This is based on the fact that one train equals 10 cars, and the passenger capacity per car for the A-Division is 182 passengers, per the AW3 loading standard. Accordingly, each train can carry 1,820 passengers (per AW3 loading), and thus 44 TPH corresponds to 80,080 passengers per hour and 38 TPH corresponds to 69,160 passengers per hour, which results in a difference of 10,920 passengers.

4 No Build Condition for Nostrand Junction

4.1 SITE-SPECIFIC CHANGES

Absent this study, no site-specific changes at Nostrand Junction are planned, programmed, or committed through the 2035 horizon year.[8] Accordingly, the existing Nostrand Junction—plus the addition of communications-based train control (CBTC), as discussed below—constitutes the No Build condition at this location.

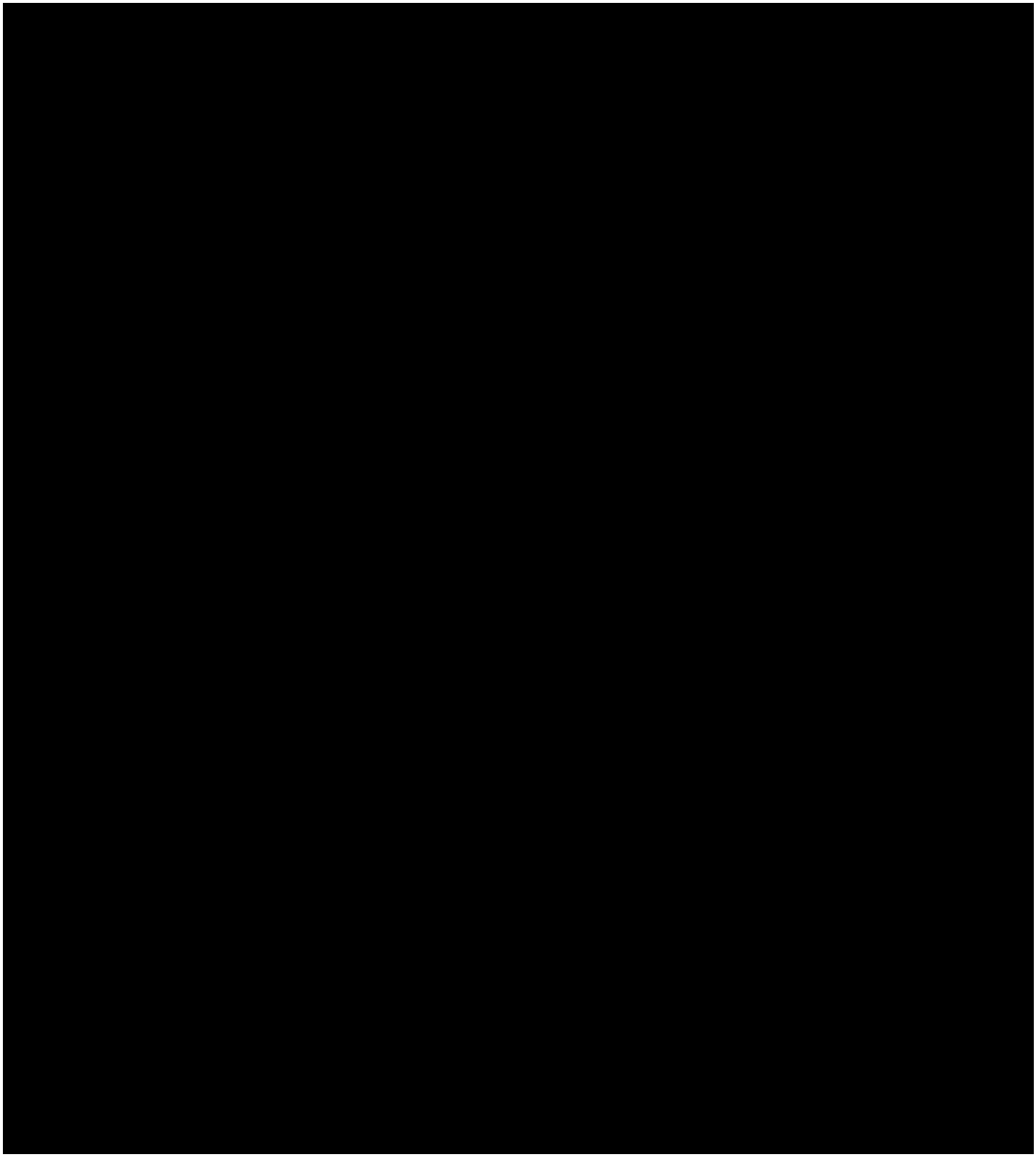
4.2 COMMUNICATIONS-BASED TRAIN CONTROL (CBTC)

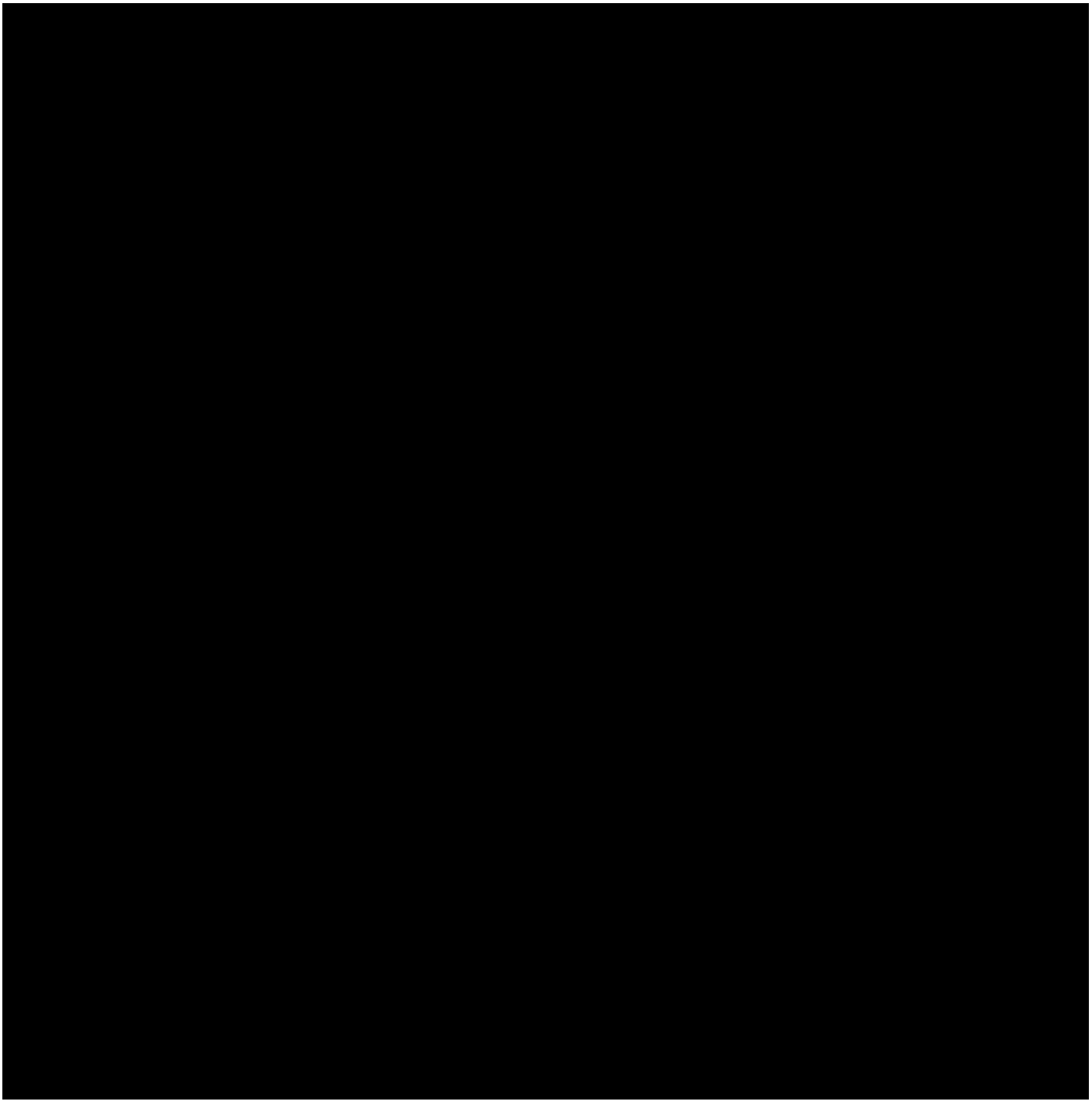
Fast Forward: The Plan to Modernize New York City Transit (Fast Forward Plan) is a 10-year look ahead plan that sets forth a vision to reimagine the subway system. A key element of the plan is the installation of CBTC signaling that has been proposed to replace segments of the existing fixed-block signaling system. CBTC is considered more reliable than fixed-block signaling, offers train dispatchers more accurate train location information, and has the potential to increase the number of trains running on each line by having trains controlled more precisely and running closer together. Specifically, with CBTC, trains can be operated in Automated Train Operation (ATO) mode which reduces train performance variability among train operators, thereby controlling trains more precisely and dynamically ensuring safe separation of trains.

The Fast Forward Plan does not propose to install CBTC on the A-Division Lines east of Nevins St Station in the first 10 years of plan implementation. However, the NYCT's A-Division Capacity Study currently underway includes train operations simulation analyses with CBTC installed and active throughout the Brooklyn A-Division Lines. Furthermore, NYCT has directed that the service plans and simulations to be performed as part of the Utica Avenue Study should use the A-Division Capacity Study simulation models with CBTC as a basis for evaluation of the Utica Avenue Study improvements packages. As such, the Utica Avenue Study is proceeding with CBTC as part of the No Build condition.

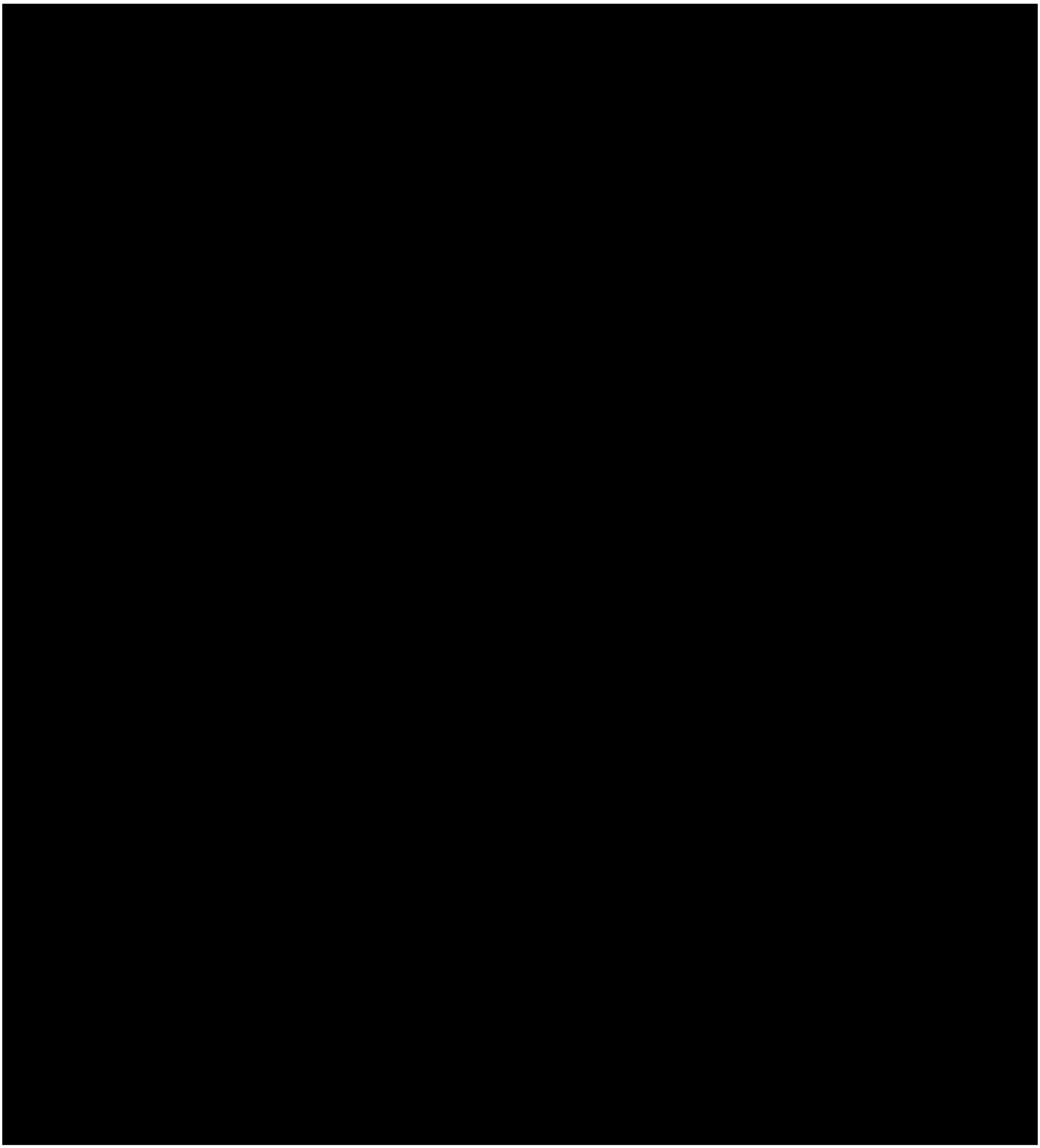
[8] The *MTA Twenty-Year Capital Needs Assessment 2015-2034* identifies the following strategy to "alleviate hotspots," but no improvements are planned, programmed, or committed: "Rebuilding critical subway junctions where lines merge and separate (such as Nostrand Junction on the 2 3 4 5 lines) to maximize train throughput and reduce delays."

5 Previous Studies for Improving Operations

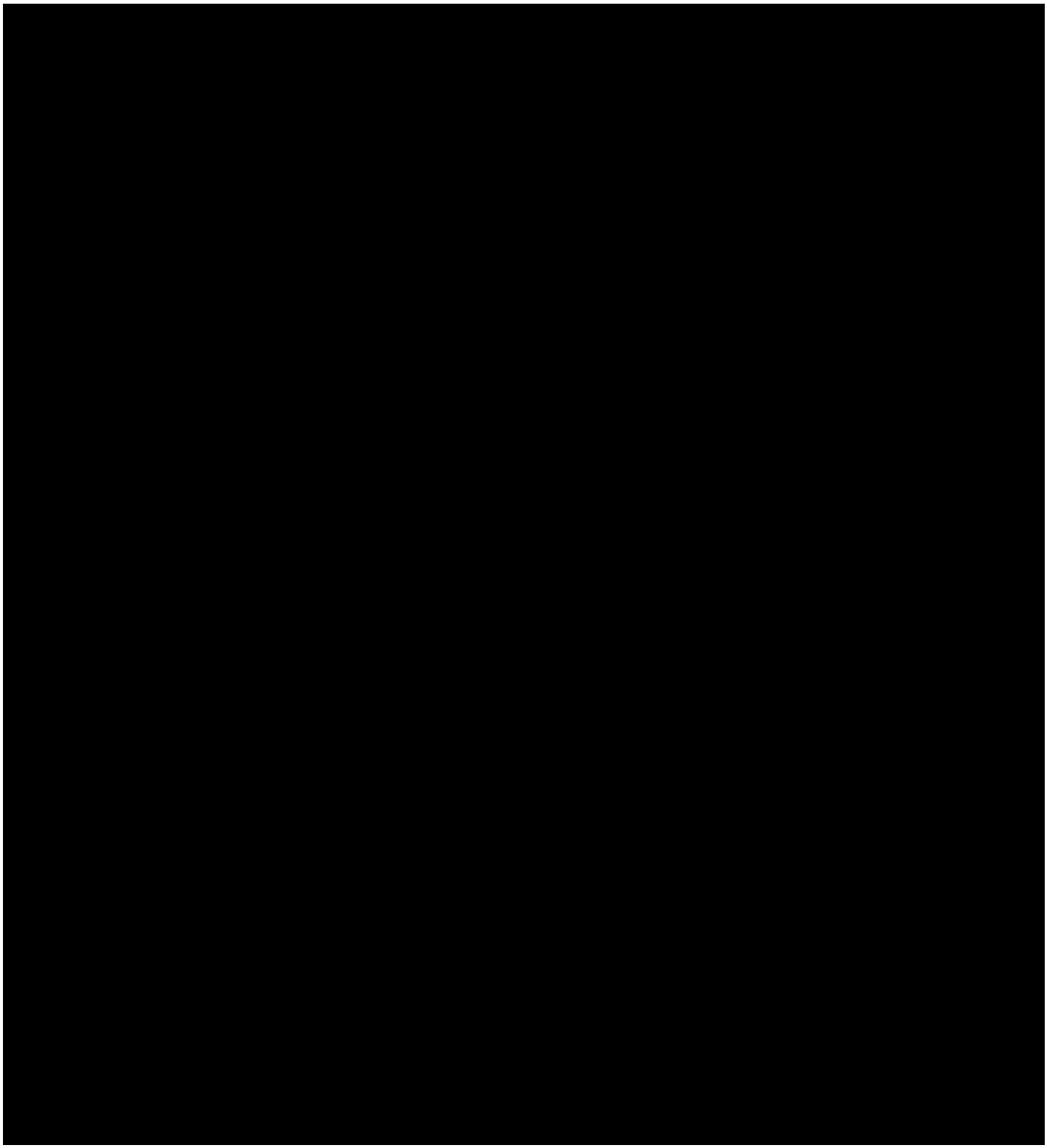




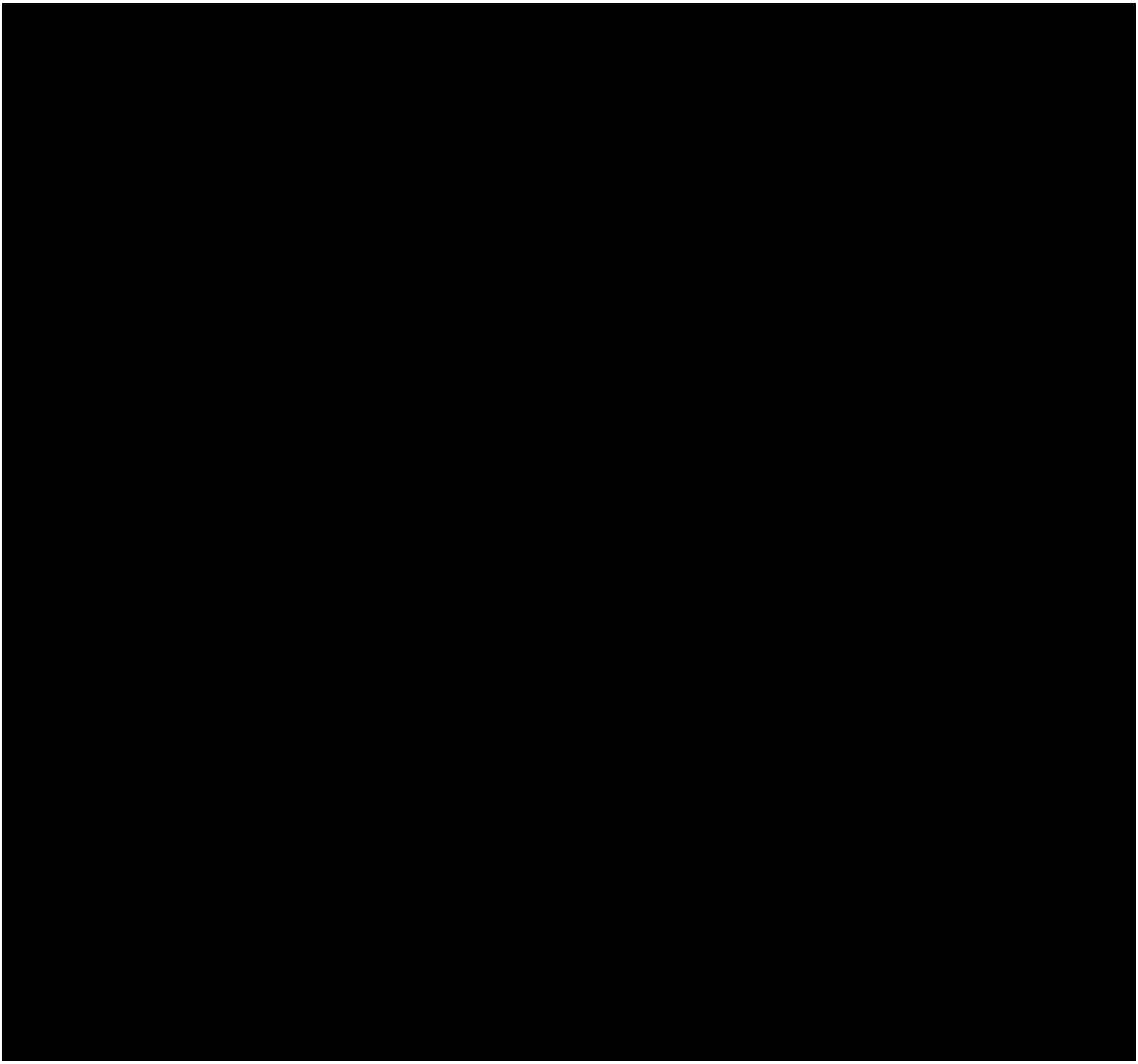
[9] The calculation of the junction TPH capacity is cited in the 1993 Nostrand Avenue Junction Study.



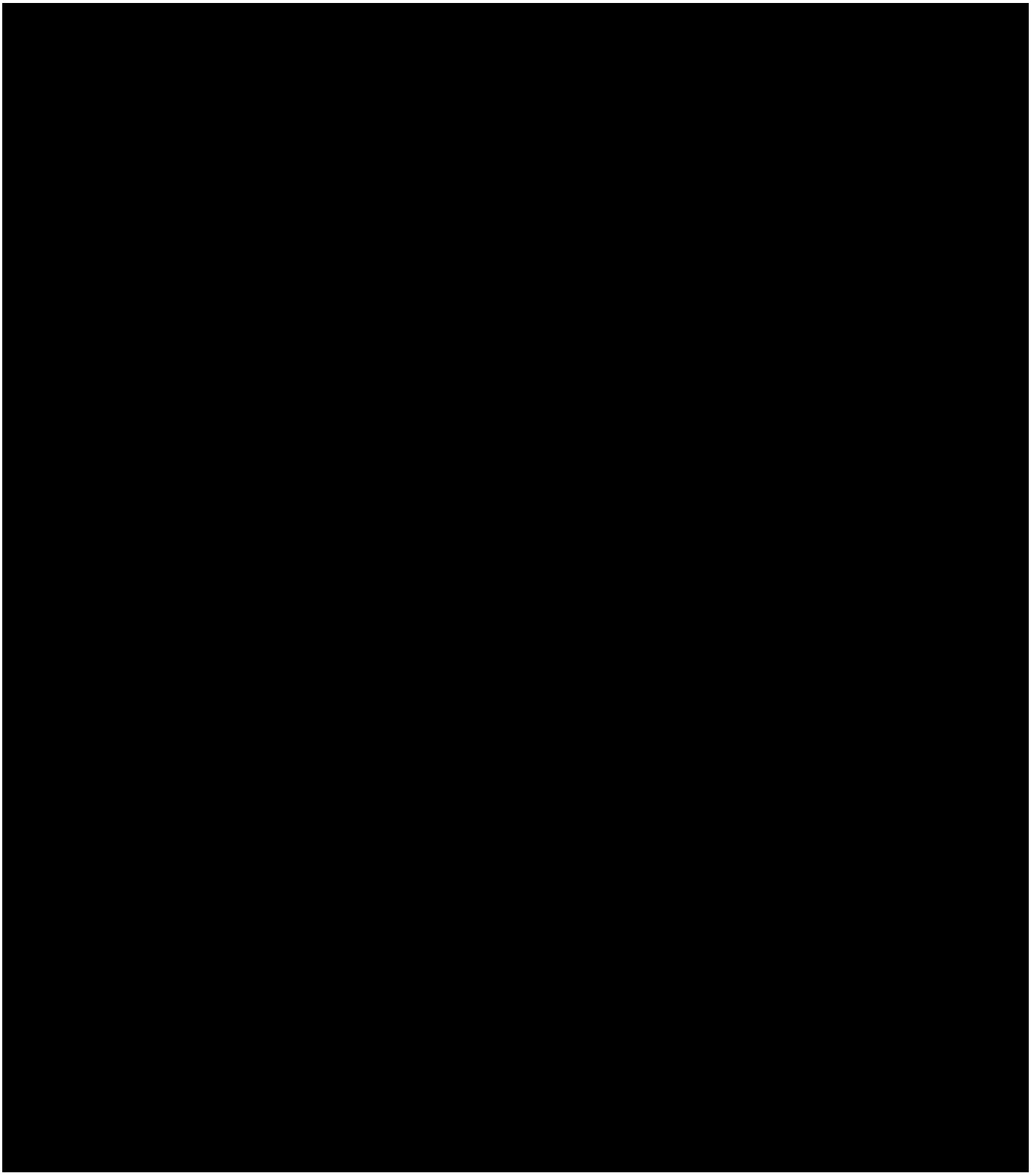
[10] The calculation of the junction TPH capacity is cited in the 1993 Nostrand Avenue Junction Study.



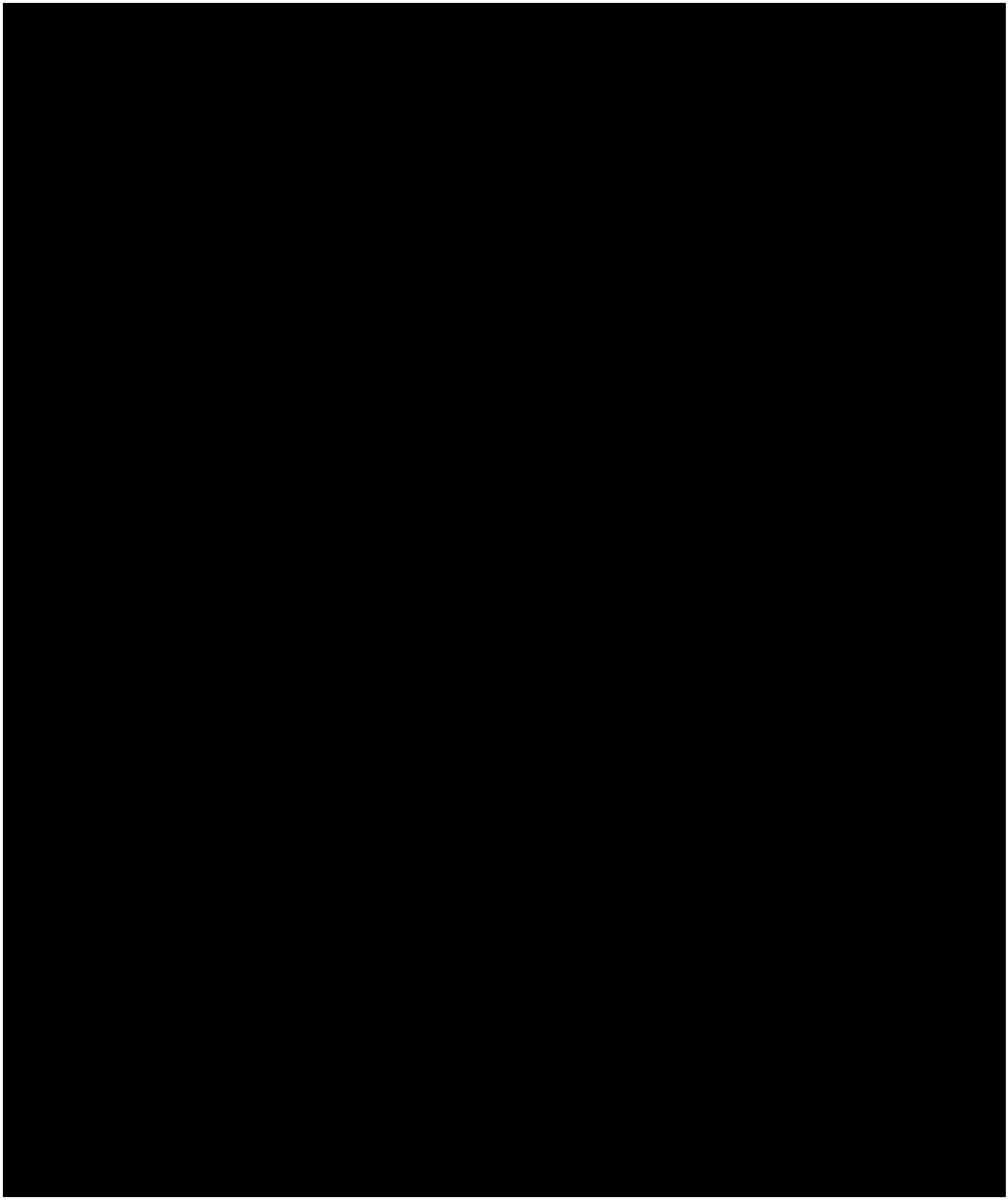
[11] The calculation of the junction TPH capacity is cited in the 1993 Nostrand Avenue Junction Study.



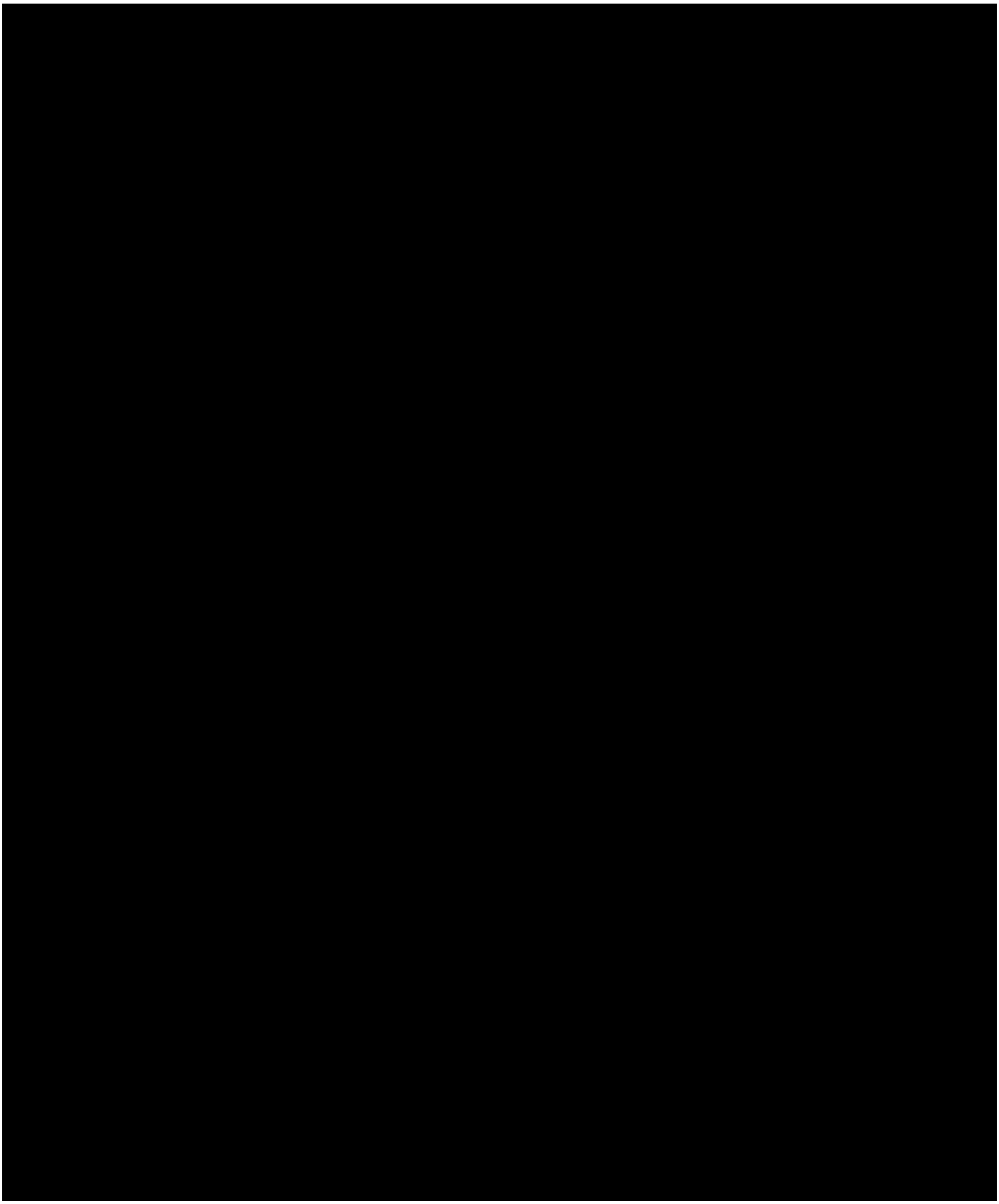
[12] The calculation of the junction TPH capacity is cited in the 1993 Nostrand Avenue Junction Study.



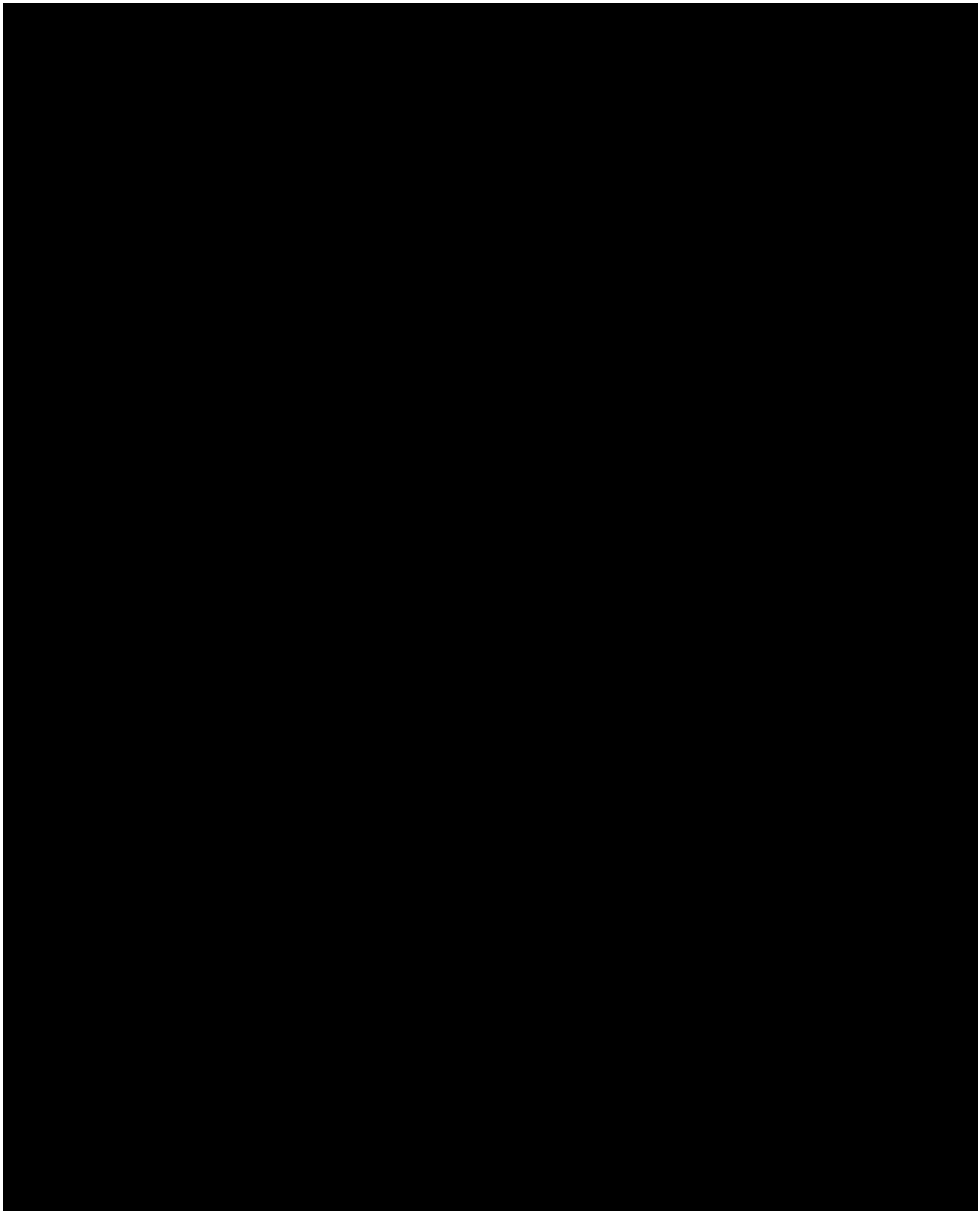
[13] The calculation of the junction TPH capacity is cited in the 1993 Nostrand Avenue Junction Study.

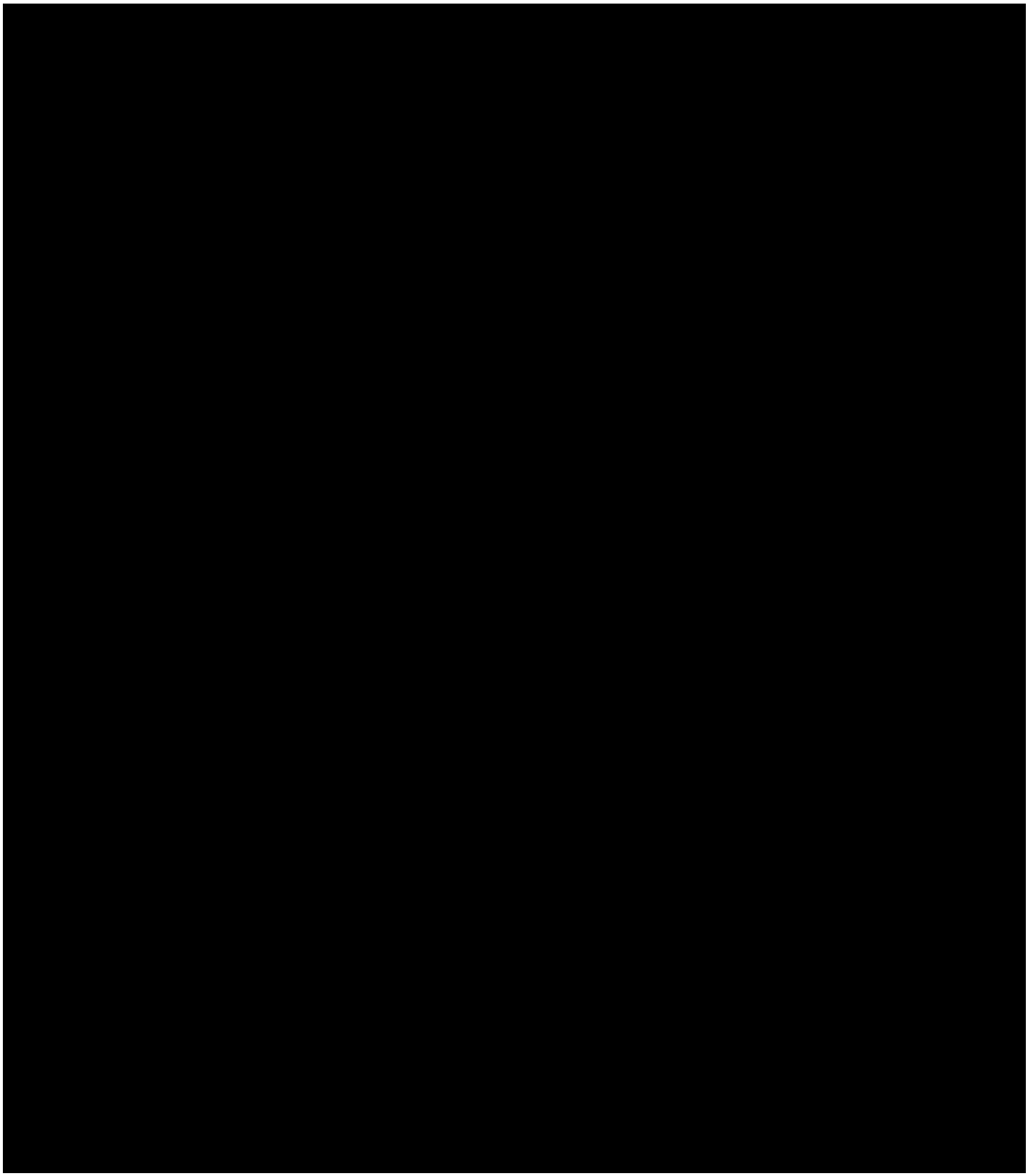


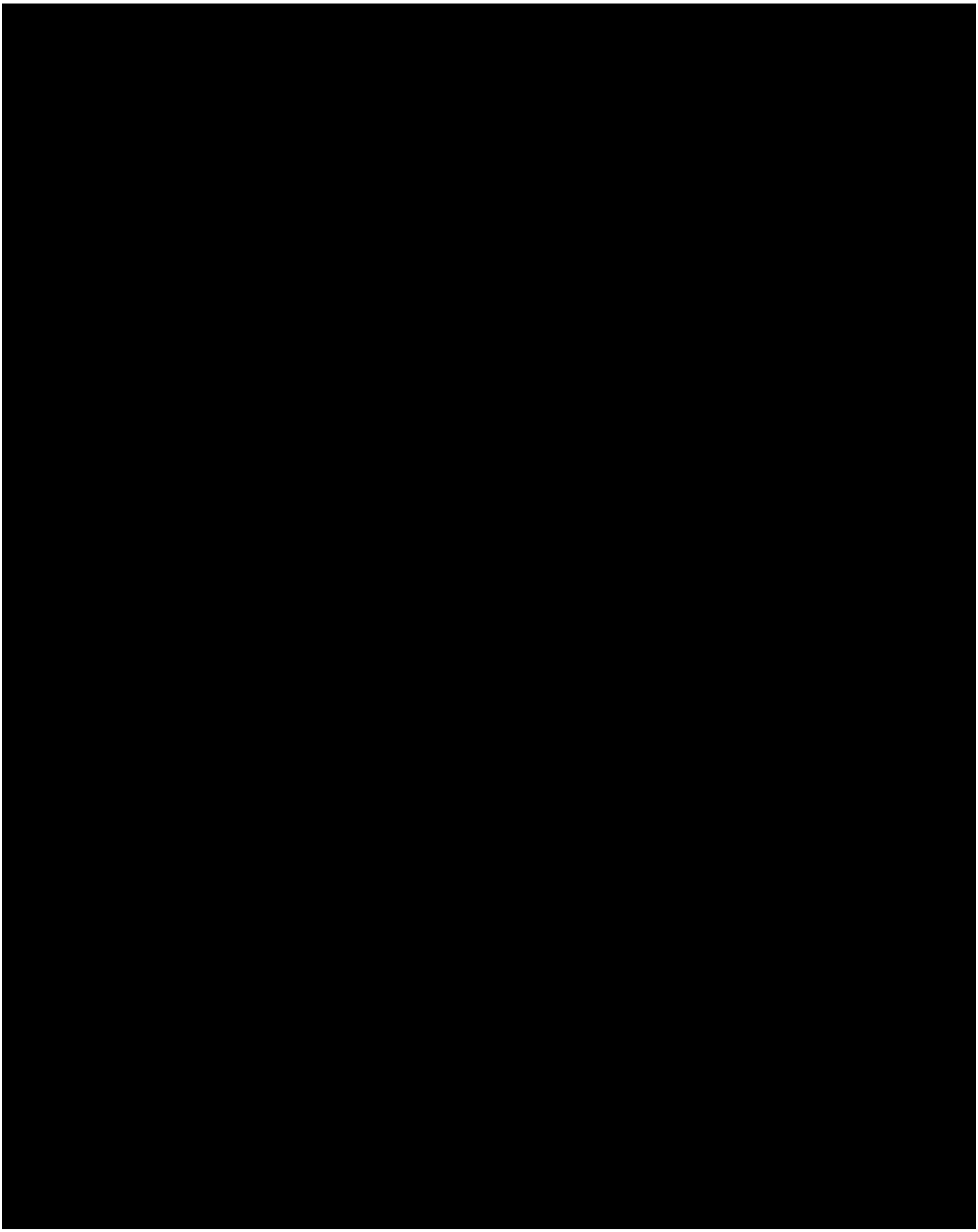
[14] The calculation of the junction TPH capacity is cited in the 1993 Nostrand Avenue Junction Study.

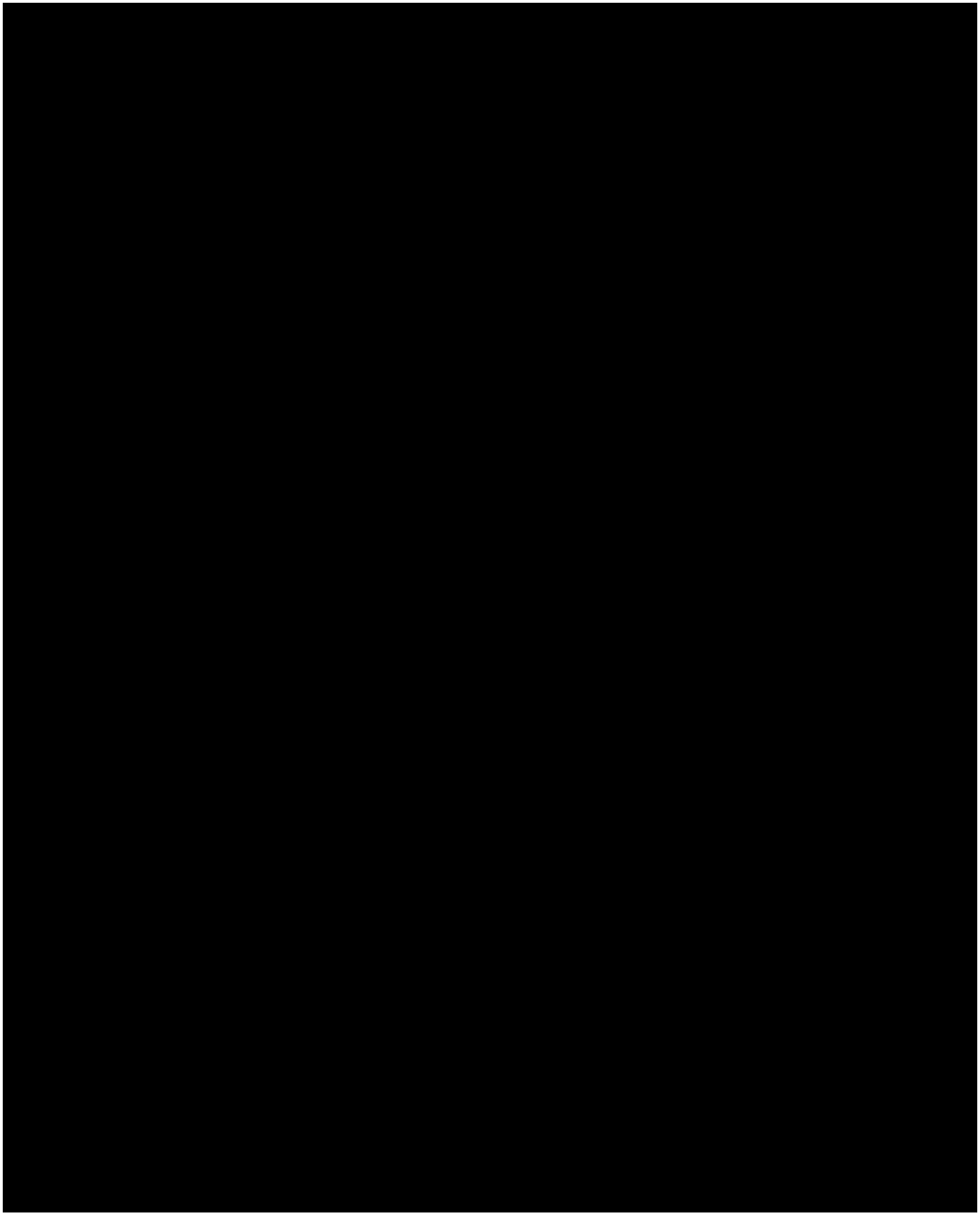


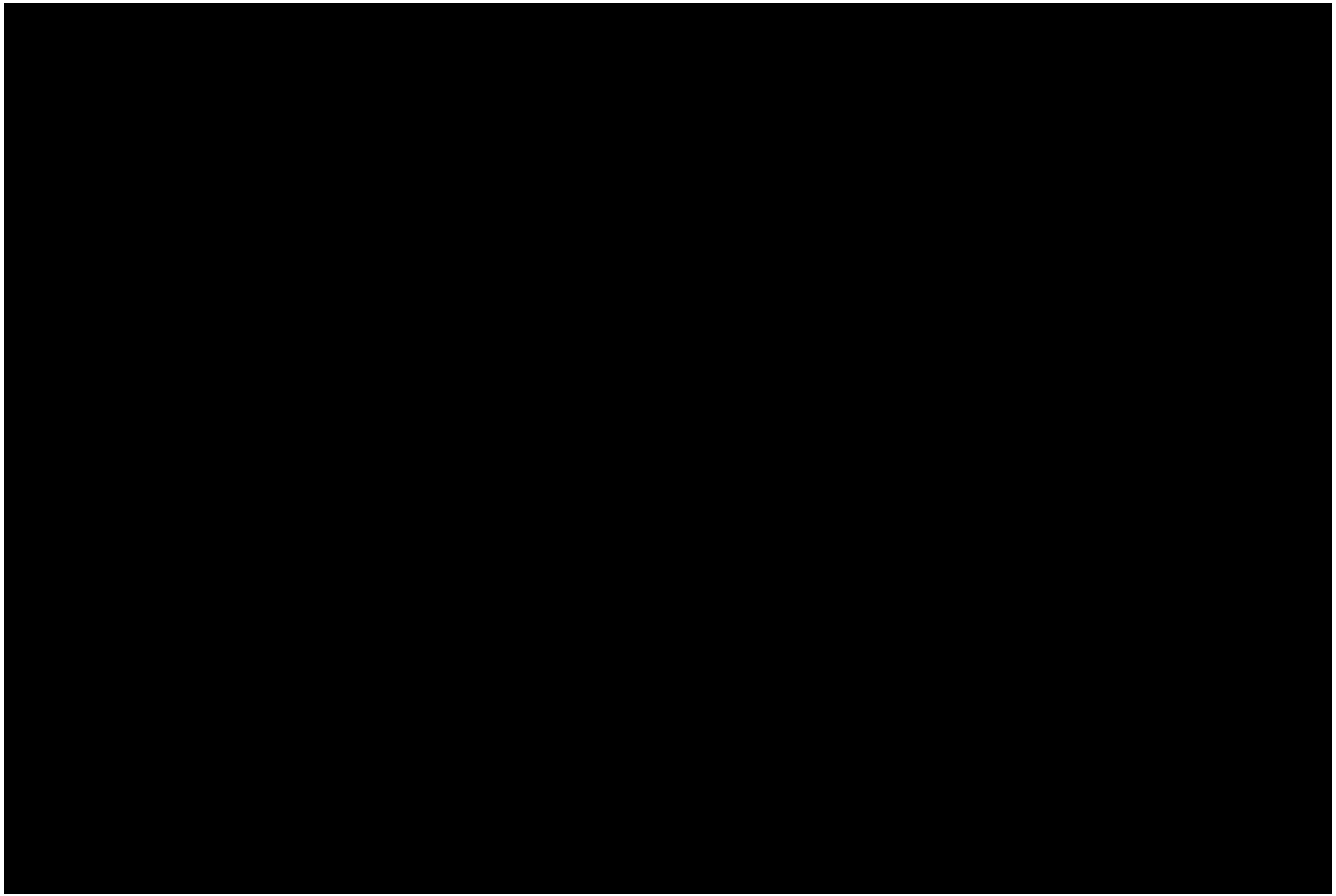
[15] The calculation of the junction TPH capacity is cited in the 1993 Nostrand Avenue Junction Study.

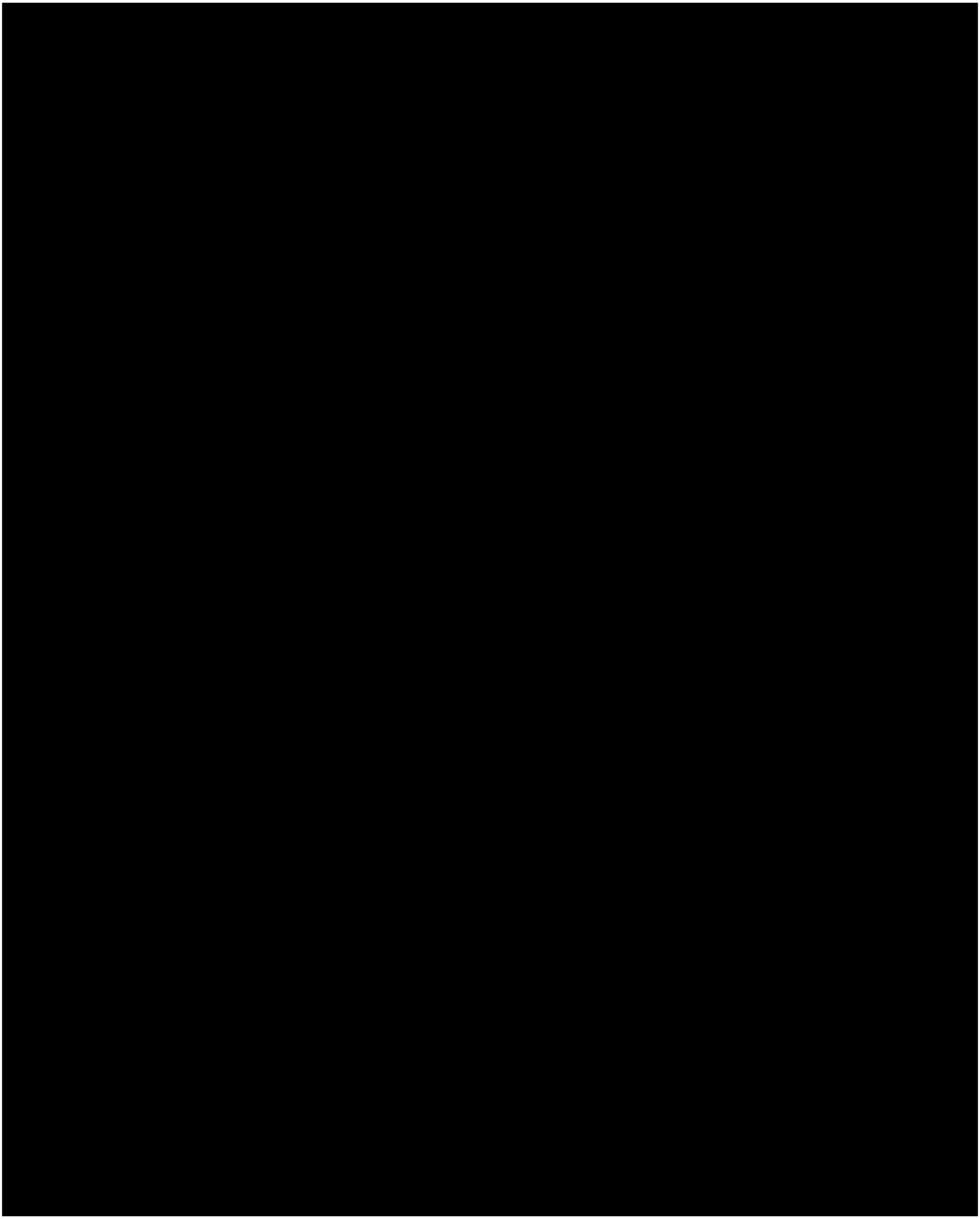




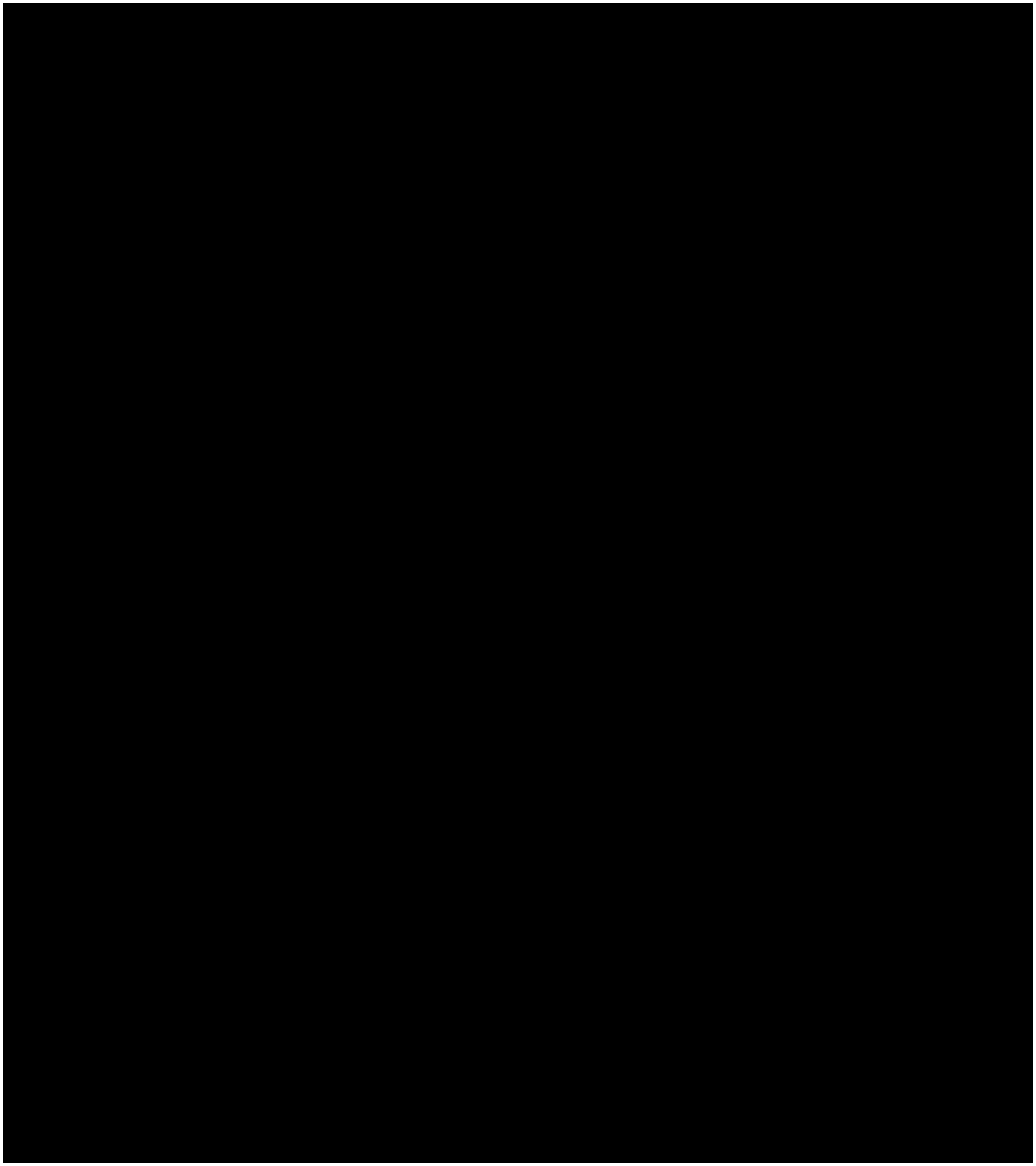








6 Preferred Option Recommendation



7 Conclusion

Since inception, the physical constraints of Nostrand Junction have led to operational inefficiencies that hamper train operations, create train delays, and thwart the ability to achieve full line capacity. Additionally, the delays that originate from Nostrand Junction can propagate to other portions of the A-Division in Brooklyn and even as far as the East Side and West Side IRT Lines in Manhattan.

The seriousness of this situation is evidenced by the fact that at least five studies have been undertaken to address this situation since the 1960s. These studies have explored and proposed different changes to the physical infrastructure, such as introducing new crossovers and grade separations, and re-routing train services for the East Side and West Side IRT Lines in Manhattan. These studies appear to have looked at all practical and financially feasible improvement options for Nostrand Junction. As part of this study, an effort was made to devise additional solutions at this location that could improve operations through Nostrand Junction, but none were identified.[20]

[20] A separate Task 2 report identifies an opportunity to address the Nostrand Junction bottleneck through an infrastructure improvement at Crown Heights-Utica Av Station.

Appendix A – Glossary of Terms

A-Division comprises the original subway lines constructed by the Interborough Rapid Transit Company. A-Division train cars are narrower than those on the B-Division/BMT-IND lines, but both divisions have the same track gauge (standard gauge 4'-8.5").

Communications-Based Train Control (CBTC) is a signaling system that uses telecommunications between the train and the track equipment to keep trains at a safe separation, manage train traffic, and ensure compliance with track speed limits. With CBTC, the exact position of the train is more accurately known than with traditional fixed-block signal systems. Within NYCT, CBTC has been introduced on the Canarsie Line (L train) and the Flushing Line (7 train).

Crossover is an interlocking between parallel tracks to enable trains to move from one track to the other.

Fixed-block signal system is a signaling system that divides each track into different fixed-length blocks with a signal at the entrance to the block to govern whether it is safe to enter and occupy that block. This type of signaling system is the most prevalent type within the NYCT subway.

Flat Junction is a junction where the tracks intersect or cross each other at-grade.

Flying Junction is a junction where the track crossings are grade-separated (do not cross at-grade) to eliminate potential train routing conflicts.

General Orders (GO) refer to the planned, scheduled alterations to the subway service, typically to permit maintenance that may affect regularly scheduled service. GOs can also refer to special event trains and other service changes.

Interlocking is a series of turnouts, the operations of which are interlocked so that trains can safely move from one track to another.

Line refers to the name of the infrastructure (e.g., Brighton Line).

Route refers to the train services that operate over a line (e.g., B and Q trains operate over the Brighton Line).

Skeletonized Track is track that is supported on a temporary wooden structure to facilitate construction activities on or adjacent to the track. Skeletonized track is absent the concrete that normally infills the space between the wooden tie blocks. As construction progresses, concrete is placed between and beneath new tie blocks to provide a permanent trackbed.

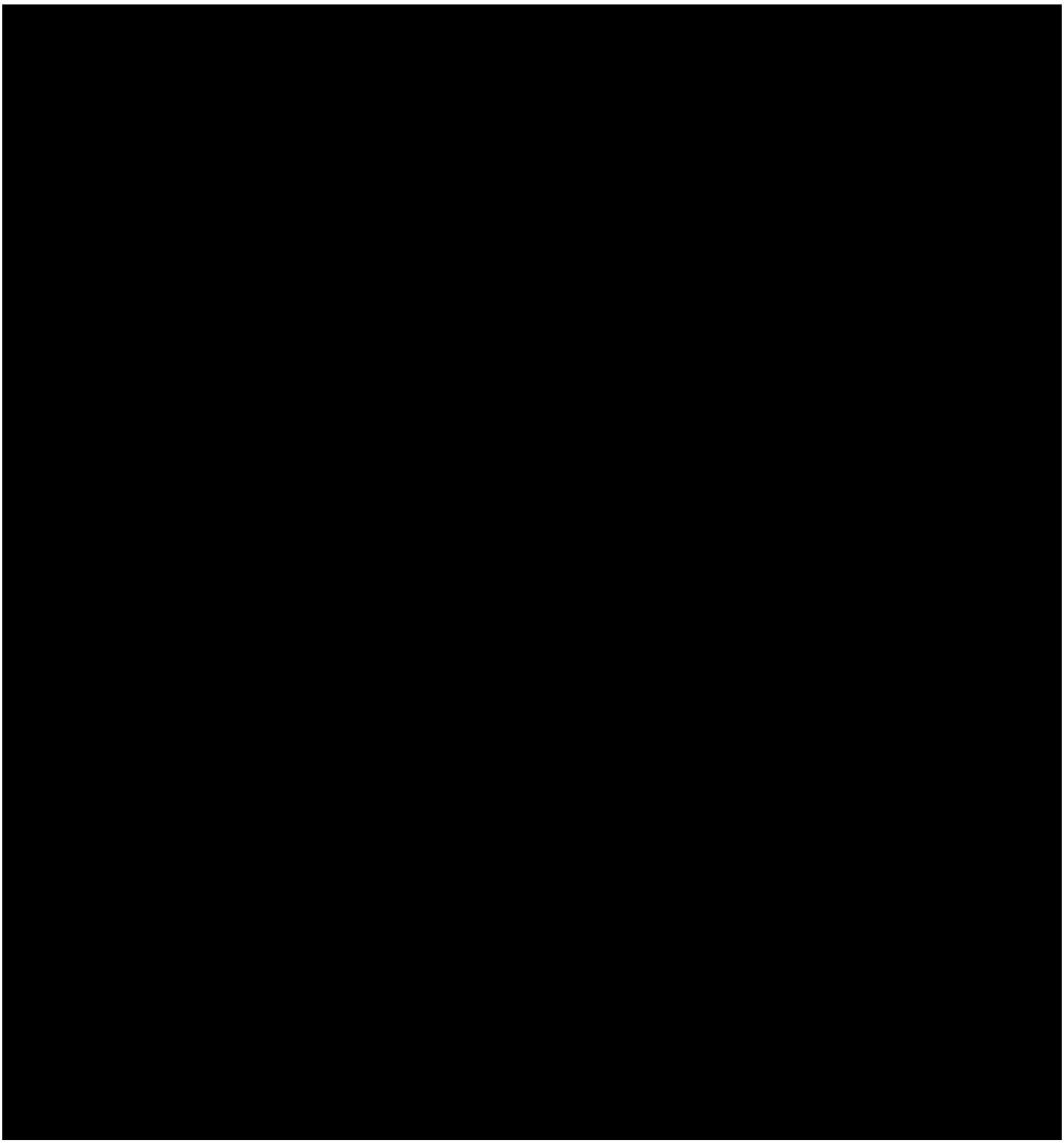
Subway South refers to subway trains operating in the southbound direction. All NYCT subway trains are classified as either operating southbound or northbound with respect to their direction of operation through Manhattan, even if they are traversing tracks that are geographically oriented east-west. "Subway South" is used to avoid confusion with the continually changing geographical direction of a typical subway line.

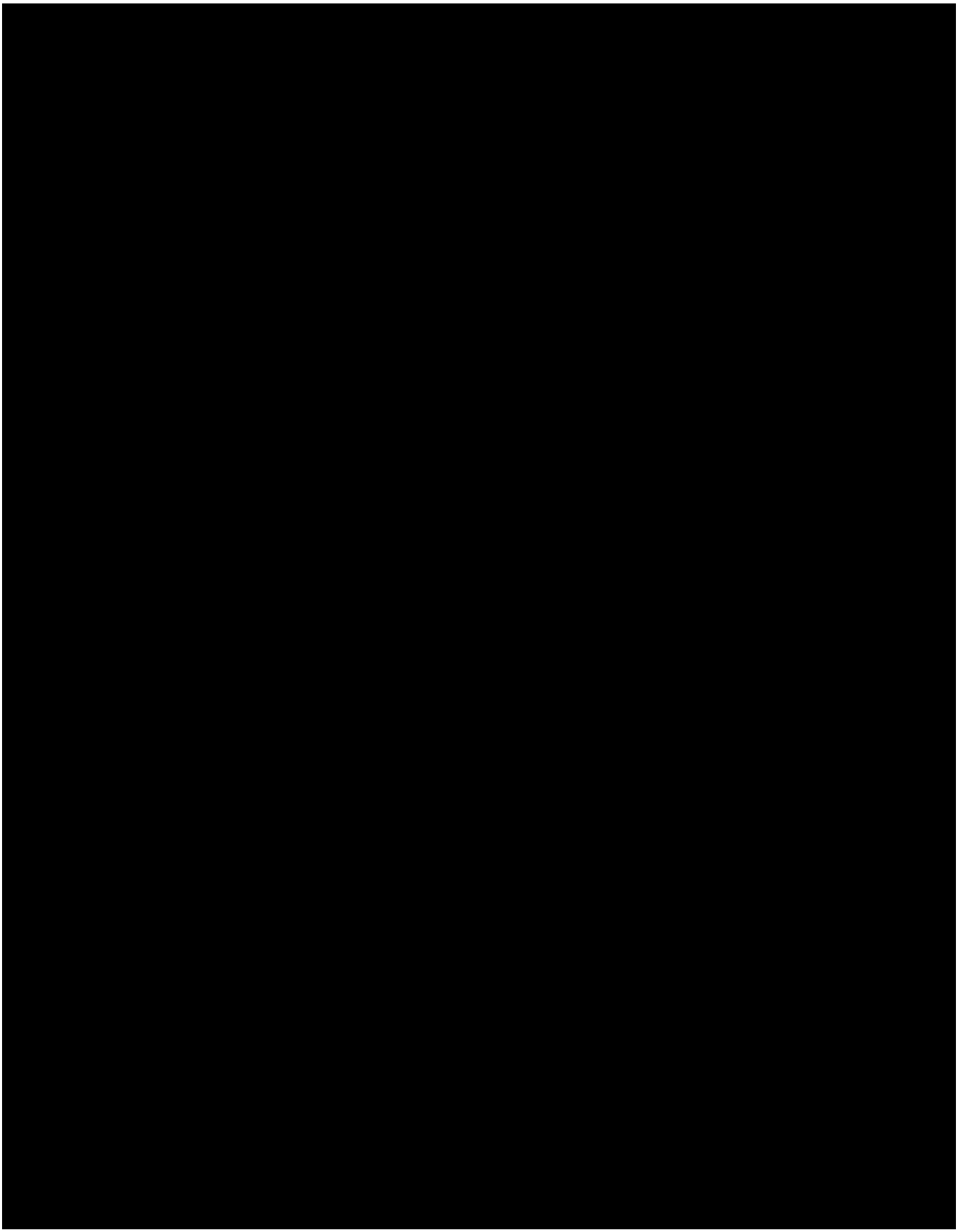
Subway North refers to subway trains operating in the northbound direction. "Subway North" is used to avoid confusion with geographic direction.

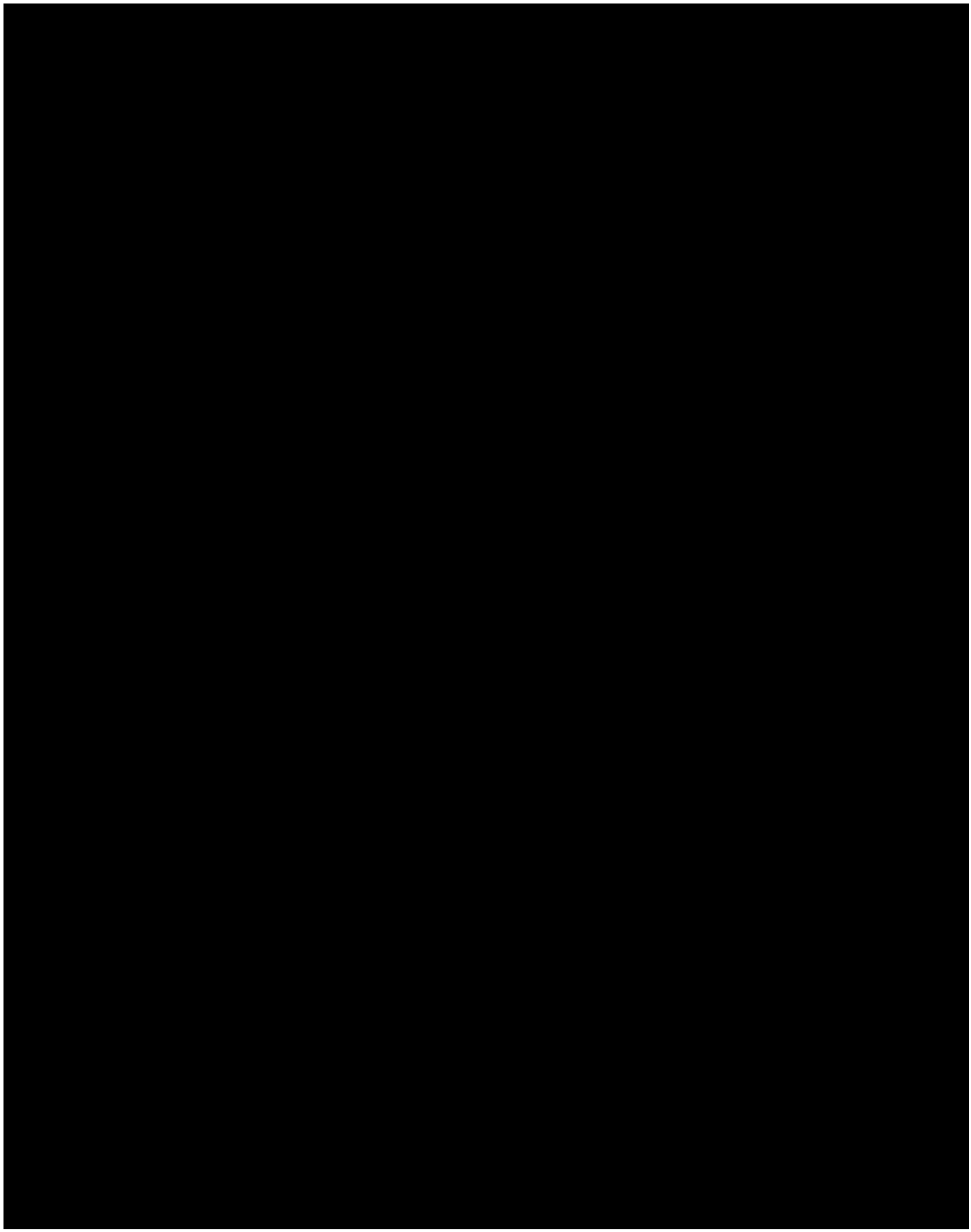
Turnout is a special track installation used to allow trains to proceed straight ahead or to switch to another track. No. XX turnout is the classification of a turnout by the inclination of the rail crossing contained in the turnout. Higher turnout numbers correspond to lower crossing angles and hence higher speeds permitted over that turnout. For example, a No. 10 turnout will permit trains to operate at a faster speed than a No. 6 turnout. Higher turnout numbers also correspond to longer turnout footprint length. A No.10 turnout occupies a longer footprint than a No. 6 turnout.

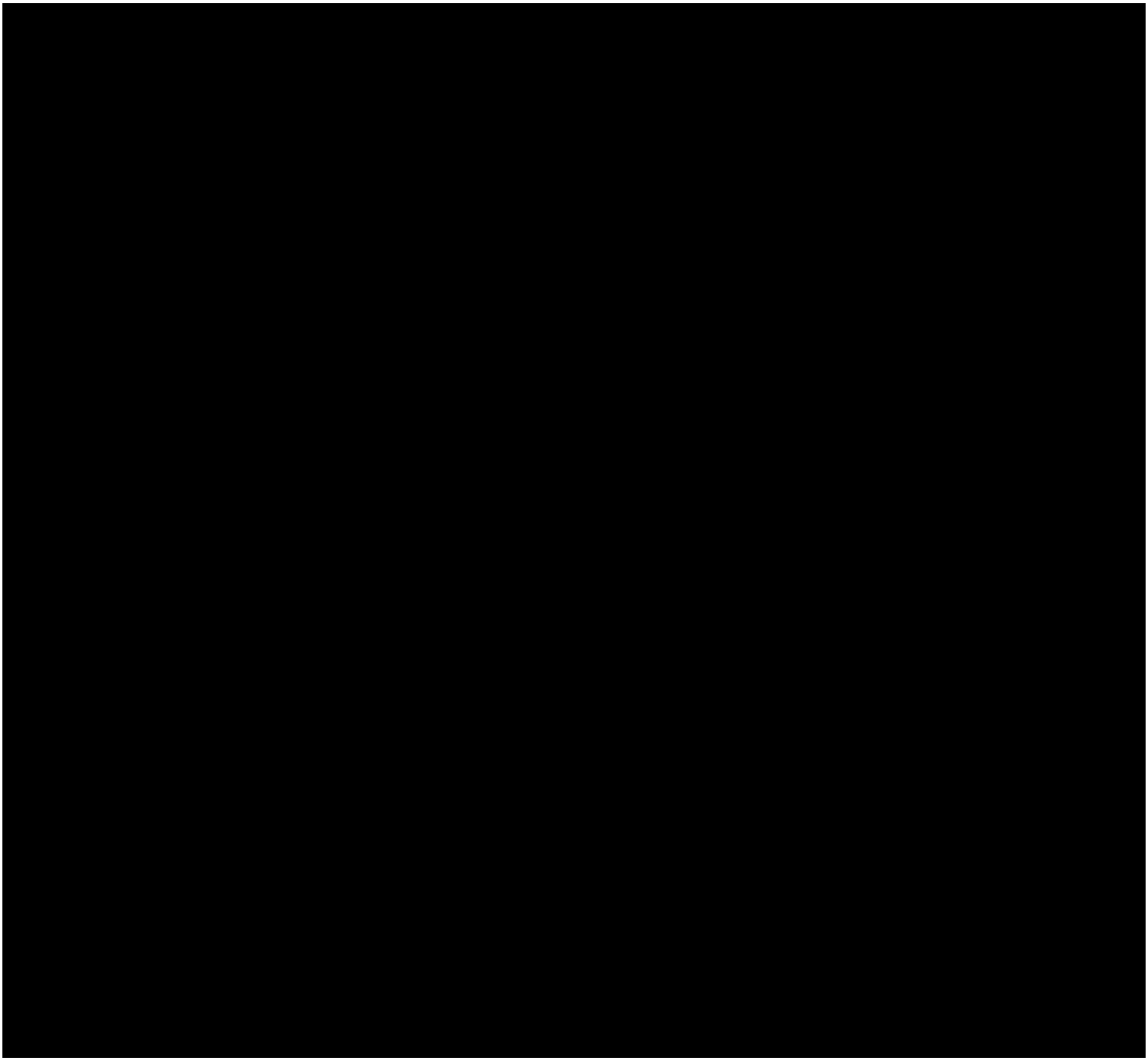
Wrench time is the actual amount of time during which field maintenance activities can be performed on-site. Wrench time excludes the time needed for traction power to be removed and possession of the track to be secured (if necessary), for workers to access the site and set up operations, for workers to clear-up for passing trains, for workers to remove equipment after working and clear the site, and for restoring traction power and placing the track back into service (if necessary).

Appendix B – Construction Duration and Capital Cost Update









[28] For example, if a project will start two years from now and last 12 months, the estimate will include 2.5 years of escalation. For purposes of consistency, the date of estimate corresponds to July 1, 2020 (i.e., the midpoint of the 2020 calendar year) for all estimates in the Utica Ave Study.